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DCIEM No. CR-2002-003

FUNCTION ANALYSIS OF AN/SQS-510 HULL MOUNTED SONAR

by:

Michael L. Matthews, Robert D.G. Webb

Human*systems* Incorporated®
111 Farquhar St., 2nd floor
Guelph, ON N1H 3N4

Project Manager:
Kim Iwasa-Madge
(519) 836 5911

PWGSC Contract No. W7711-7-7404/01-SV
Call-Up 7404-12

On behalf of
DEPARTMENT OF NATIONAL DEFENCE

as represented by
Defence and Civil Institute of Environmental Medicine
1133 Sheppard Avenue West
North York, Ontario, Canada
M3M 3B9

DCIEM Scientific Authority
Sharon McFadden
(416) 635-2189

DECEMBER 2001

104-05482/

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Abstract

This report provides the results of a function analysis of the AN/SQS-510 Hull Mounted Sonar deployed on Halifax class ships. The analysis was based upon available system and Navy training documentation and interviews with Defence Scientist and Navy subject matter experts. The analysis revealed a high degree of dependency among a number of critical functions whose accurate completion is required for the successful detection and classification of contacts of interest. These functions included the determination of the oceanographic model, the appropriate configuration of transmission parameters and the correct selection and use of display modes on the operator's console. The validation interviews also revealed that automated processes for detection were generally not used under operational conditions because of high false alarm rates and associated increases in operator workload. The present analysis should be interpreted in conjunction with an earlier report that provided an updated function analysis of the CANTASS system.

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Executive Summary

This report provides the results of a function analysis of the AN/SQS-510 Hull Mounted Sonar deployed on Halifax class ships. The analysis was conducted by first reviewing background documents related to the design of the system, operational procedures, training material and computer based lessons. A preliminary list of functions and associated function flow diagrams were then prepared and reviewed for accuracy and completeness with a Defence Scientist with expertise in the system. The revised functions and flows were then validated using Navy subject matter experts from the Canadian Forces Naval Operations School in Halifax and actively serving sonar operators from HMCS Montreal.

The analysis revealed a high degree of dependency among a number of critical functions whose accurate completion is required for the successful detection and classification of contacts of interest. These functions included the accurate determination of the oceanographic model, the appropriate configuration of transmission parameters and the correct selection and use of display modes on the operator's console. The validation interviews also revealed that automated processes for detection were generally not used under operational conditions because of high false alarm rates and associated increases in operator workload.

The present analysis should be interpreted in conjunction with an earlier report that provided an updated function analysis of the CANTASS system and the Towed Integrated Active Passive System under development. The operational goal of building the underwater picture by the underwater warfare team is normally achieved by using and correlating information across a number of sonar systems such as the AN/SQS-510, CANTASS and Sonobuoy Processing System, supplemented by information from the ship's helo and possibly Maritime Patrol Aircraft. Hence, to fully comprehend this process, the separate function analyses need to be interpreted in this broader context.

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1. Introduction

This report provides a function analysis and function flow diagrams for the AN SQS 510[1] Hull Mounted Sonar system currently deployed in the Canadian Navy. The report has been prepared under the Scientific Authority of Sharon McFadden at DCIEM (Contract # W7711-7-7404/01-SV). This work represents a continuation of two related tasks: (a) a review and update, of the original YARD (1989) function analysis performed on CANTASS to reflect current operational practice and (b) a preliminary function/critical task analysis and heuristic human factors review of the Towed Integrated Active Passive Sonar (TIAPS) concept under development at DREA (Matthews, Webb and Woods, 2001).

The general goal of this program of work is to analyse Human Factors (HF) issues relating to the role of the operator and the operator machine interface (OMI) in sonar systems, with a view to providing documentation for military planners and system designers to assist the specification, design and evaluation on future sonar technologies. The analysis should provide a basis for identifying particular problem areas and understanding the relationship between individual tasks and functions, the overall system design as they contribute to achieving mission objectives.

[1] For convenience, this will simply be referred to as "HMS" (hull mounted sonar) in the balance of this report

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2. Description of Function Analysis

2.1 Definition of Function Analysis

According to NATO RSG14 (1992)

> *"Functions represent one level in the hierarchy of total system activities. This hierarchy comprises various levels of which the highest level describes system missions and the lowest level describes operator task elements. To identify relevant system functions, the analysis starts with the mission of the human-machine system. By decomposing the mission, mission scenarios and then system operations can be identified which are required for fulfilling the mission. Finally, the decomposition of system operations leads to the system functions, which are the basis for all human engineering activities during system development. The lowest activity level which human engineers deal with is the level of operator task elements."*

The tasking for the present work required a focus the analysis on major system functions. This involved decomposition normally down to the third level where appropriate, and avoiding, wherever possible, decomposition down to the detail of specific operator tasks (e.g. tasks involving operator actions such as inputting data and reading information from displays). Further, it was not thought necessary to perform a full mission analysis, since this area had been covered in the YARD report and only a limited number of mission types was considered likely. However, as is noted in a later section of the report, there was some discussion with both DND and Navy subject matter experts (SMEs) of the types of missions where active sonar would be employed.

In general, there are two different perspectives that may be brought to examining and describing the functions of the system of interest. The operational perspective looks at the system in terms of what mission goals it is designed to achieve, and defines the necessary functions that comprise the process. The systems engineering perspective uses the word "function" somewhat differently, usually to describe some attribute of the system hardware and or software. For example, tools provided by a system to assist the sonar operator in the analysis of sonar lines of interest are software functions. For present purposes, the view has been adopted to examine the system in terms of its potential role in an operational environment; thus, the system software functions have been integrated, where possible and appropriate, into this perspective.

While function analysis may follow a variety of approaches, the SOW requires a product that follows the format adopted in the YARD (1989) analysis of CANTASS, namely a hierarchical listing of functions with their individual descriptions and a separate function flow diagram. This approach shows the sequential arrangement of functions as well as functions performed in parallel. (Note: the typical use of the term *parallel* in a function analysis does not mean that the operator necessarily is required

to perform tasks in parallel. Instead, it represents a group of functions whose completion or output is required before a subsequent function).

2.2 Format of Function Descriptions

The descriptions and analyses of each function use the following standard categories.

Name of Function

The function name should be, as far as possible, unambiguous yet understandable to an expert as a recognisable function.

Mission Under Which Function Occurs

This would normally be a cross-reference to the mission analysis. In the present case the description notes which missions a function may exist under.

System Units Which Support Behavioural Function

The hardware dependency of a function will be considered in general this is the AN SQS 510 system

Superordinate Functions (Where Appropriate)

This category maintains a record of the immediate superordinate function or functions that it helps to satisfy.

Sequential Categorisation of Functions

The function is categorised according to its temporal relationships to other functions. For example a function may follow the previous function in a strictly serial fashion. Alternatively, the following function may be only one of a number of functions that could be executed at that point in time. The following standard categories were adopted:

> DIRECT. This type of function follows directly from the previous function.
>
> OR. This type of function is one of a group of tasks that could occur next, but only one of which does, i.e., function 1 OR function OR function 2, etc.
>
> AND. This type of function is one of a group of functions that could occur next, but the ordering within the group is not determined rigidly. This may occur where the ordering of a group is not fixed at the onset of a procedure but is determined by the outputs of previous functions.
>
> CONCURRENT. This type of function will be one of a group of functions, which occur simultaneously.

In addition to the above categories, functions can also be described as DISCRETE, CONTINUOUS, or ITERATIVE. A function is *discrete* if it has a recognisable end point with output. A *continuous* function is active at any point in time within specified beginning and end points. An *iterative* executes until an output criterion is reached and then terminates.

Estimate of Criticality of Function

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A critical function requires successful completion in order to achieve mission or system goals. This is a subjective estimate based upon SME opinion.

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Required Quality of Output for Function

An estimate of the quality of output of function to assess the consequences on subsequent functions of degraded performance of that function. This category is related to the categories *Interdependency of Functions*, and *Consequences of Failure to Complete a Function*.

Estimate of Probability of Failure to Complete a Function

This is a broad SME estimate of failure likelihood, possibly in areas that may be most sensitive to heavy workloads.

Consequences of Failure to Complete a Function

This category may be information that is partly elicited from SMEs and partly deduced from other categories of information such as *Required Quality of Output for Function* and *Interdependency of Functions*.

Estimate of Time to Completion

An approximate estimate, where possible, of the time to completion for a function. This is not appropriate for some functions, for example like monitoring displays, which is continuous throughout a mission.

Sub-functions or Tasks

This provides information on the decomposition of each function into sub-functions or, at the lowest level, tasks. These sub-functions or tasks need not be unique to that function.

Sequencing of Sub-functions or Tasks

The sequencing of the identified sub-functions or tasks is outlined, usually by cross-reference to the Function Flow Diagrams

Allocation of Function to Operator/Hardware/Software (Where Appropriate)

Assignment of individual functions to operator, hardware or software, or combinations thereof.

Interdependency of Functions

This shows the extent to which a function relies upon the outputs of other functions, usually by cross-reference to the Function Flow Diagrams

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3. Method

An initial familiarisation with the active sonar domain was conducted by reviewing available documentation relating to the AN SQS 510 Sonar system. A listing of the documents consulted is shown in the Bibliography below. The result of this process was a preliminary list of functions that would serve the basis for discussion with SMEs.

The next step involved interviewing a Defence Scientist at DND headquarters who had expertise in AN SQS 510 system with a focus on the following areas:

- Identifying mission types
- Using the preliminary function list to identify all major system functions
- Organising the functions into a relationship hierarchy
- Reviewing each function in terms of the major descriptive categories (as above)

As a result of this process, a function list and associated descriptions were generated and a preliminary function flow diagram was created. These two products were then reviewed by Navy SMEs at CFNOS to validate the results and to provide suggestions for modifications. The Navy SMEs comprised two sonar trainers who were formerly an ASWC and SCS, an active SCS and two HMS operators from HMCS Montreal.

The function analysis and flow diagrams resulting from these processes are shown in the next section and annexes.

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4. Results

The results are organised as follows:

- An overview of mission types
- A listing of the HMS functions
- A description of each function (Annex B)
- Function Flow Diagrams (Annex C)

4.1 Mission Types

Although there was no specific mandate in this project to explore Navy underwater warfare missions in any detail, it became apparent during the interviews with the Navy SMEs that the specific operation of the HMS at any time depended upon the current mission requirements. Four types of missions were described:

- Detection
- Flushing out
- Deterrence
- Silent passage

In a detection scenario, the goal is to detect possible threat contacts within the area of interest (AOI) this may require largely passive sonar operations (CANTASS) supplemented by HMS when tactically appropriate (e.g. the types of contacts anticipated), or when oceanographic conditions constrain the deployment of the array. For flushing out, the goal is to move a contact out of the AOI, and for deterrence the goal is to prevent a contact from entering the AOI. In both cases, HMS would play a major role as would the deployment of sonobuoys and the use of the helo and possibly MPA. For silent passage, only passive sonar would be employed, possibly supplemented by helo surveillance.

4.2 Active Sonar Functions

General description: In the active state, the HMS transmits Linear Period Frequency Modulated pulses, referred to as FM, or CW acoustic pulses and then receives and processes the acoustic energy reflected by underwater objects. In the listen state acoustic signals are passively received by the system and the sonar does not transmit in this mode.

The following table provides a comprehensive listing of all the functions that have been determined. The "comments" column elaborates upon each function and adds contextual information to allow the reader to better comprehend how the function is performed.

Function	Comments
1. Configure system	
1.1. Configure operational mode	Normal, shallow or mine. Whole process takes about 30 seconds if enviro info available. Overall direction for settings comes from ASWC, these are fine tuned and optimised for current conditions.
1.1.1. Receive and analyse environmental information	Weather, sea state, ambient noise. 30 minutes but could take hours in complex situations
1.1.2. Obtain and analyse bathy information	Frequency: minimum 4x day – up to every 15 mins if threat Task sequence is: drop bathy; analyse enviro info, write up info from bathy, input into Allied Environment Support System (AESS).
1.1.3. Select velocity of sound in water	
1.1.4. Calculate predicted ranges for acoustic systems	
1.1.5. Provide oceanographic brief to Ops Room	Done at least 1x day – more frequently if enviro conditions change.
1.2. Receive frequency assignment and sector allocation from TG	Feeds into 2.6
1.3. Set environment parameters	E.g. ship's roll/pitch, speed, heading etc.
1.4. Select system state	"Listen" or "active"- default is listen
1.5 Configure active mode	Omnidirectional, DTN, DTW
1.6. Select detection mode	ADT or PCAD; the latter would be off for Littoral or mine ops Operators remarked that PCAD and ADT are never actually used because of high false alarm rate and additional workload generated in deleting false tracks.
1.7. Configure passive mode.	
1.8. Set data recorder	
2. Configure transmission parameters	About 1 minute to complete.
2.1. Define transmission groups	
2.1.1. Set frequency	
2.2. Select transmission group for operational context	Normal, shallow water, mine avoidance.
2.3. Select transmission parameters	Range/transmission interval of the watch (TIOW), frequency, mode, power level- type FM/CW
2.3.1. Select mode	Omnidirectional, DTN, DTW
2.4. Select auto or manual transmission initiation	
2.5. Select synchronisation parameters	Iroqois class only
2.6. Set directional transmission bearing	
3. Build and maintain picture	This is largely the underwater picture - but occasionally includes those aspects of the surface picture amenable to detection by sonar systems.
3.1. Analyse passive acoustic data	Only used for correlation with active for picture compilation. Audio quality is poor. Many possibilities for false alarms.
3.1.1. Monitor passive display	Using broad band
3.1.2. Detect bearing of noise spoke	
3.1.3. Listen to source	Insufficient quality for analysis.
3.1.4. Classify track	Normally would require correlated info from other source such as CANTASS, SPS, MPA.
3.1.5. Create regional track	Done by HMS operator

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Function	Comments
3.1.6. Report track to CCS	Done by SCS/ASWC – track classification authority varies with command level.
3.1.7. Update track	
3.2. Analyse active acoustic data	Typically takes about 2 minutes after initial detection
3.2.1. Select acoustic data presentation mode	PSCAN, ASCAN, BSCAN, TSCAN, DSCAN or dual combinations. Operator starts with full ASCAN, when contact detected creates track and switches to BSCAN/DSCAN to get Doppler then BSCAN/TSCAN for tracking.
3.2.2. Selective active mode and Initiate transmission	
3.2.3. Monitor acoustic data	
3.2.4. Detect acoustic signal	Operator looks for a sequence of 3 echoes; output goes to Initiate Tracking. Looks at PSCAN for BB correlation
3.2.5. Process Contact	Maximum number of contacts that could be handled for a short time period is 6. Realistically 3-4 would be the limit under sustained operational conditions. May take as little as 2 minutes for the whole process.
3.2.5.1. Select track management mode	OIT, ADT, PCAD. Automated mode tends not to be selected because of high false positive rate.
3.2.5.2. Create Track	
3.2.5.3. Localise contact	
3.2.5.3.1. Determine bearing	
3.2.5.3.2. Determine range	
3.2.5.3.3. Check track quality	
3.2.5.4. Update track	OIT only. Add course and speed based upon movement of initial symbology[2]
3.2.5.5. Correlate with passive data	
3.2.5.6. Classify track[3]	E.g. "sub-surface unknown"
3.2.5.7. Report regional track	This track is local to the HMS operator.
3.2.5.8 Assess track	SCS assesses/verifies info and reports track to CCS SCS and ASWC resolve ambiguous tracks.
3.2.5.9. Pass contact information. Report track to CCS.	OOW watch may look for correlative info if requested by SCS.
3.2.6. Maintain detection	
3.2.6.1. Change Tx parameters as required	Requires command authority. Only required to improve picture or verify. Influenced by contact speed, depth and water level conditions. This would allow contact to be held longer than with initial settings. Go to Monitor acoustic data.
4. Manage Tracks	Done by SCS using info from CANTASS and SPS when appropriate
4.1. Delete active tracks	These could be false alarms, tracks from consorts or other known contacts.
4.2. Drop and restore tracks	May require command authority. SCS tells HMS operator to drop.

[2] This can be a major source of error if symbology is not entered in the precise location. When the operator switches from ASCAN to BSCAN then symbology may be well off the actual echo position. The system then reports wrong bearing and wrong speed (e.g. 90 knots).

[3] In classifying a contact the track types in decreasing order of threat are: torpedo alerts, acoustic bearing lines, ADT reportable to CCS, OIT reportable to CCS, ADT not reportable to CCS, OIT not reportable to CCS, CCS tracks - i.e. reported to the sonar by the CCS.

Function	Comments
4.3. Process lost contacts	Operator reports after three sweeps of no contact. Switches to DTW, if still no echo then meets criterion for lost. Lost contact declared at SCS level. Standard search procedures initiated for lost contacts. Lost tracks will eventually increase display clutter.
4.4 Correlate tracks	Other available sensor information (e.g. from sonobuoys, CANTASS).
5. Conduct torpedo procedures	
5.1. Monitor passive acoustic data	Operator looks for noise spoke
5.2. Determine if torpedo	Worst case is if no prior contact. Op does not normally monitor at passive data on upper monitor.
5.3. Select QAB Alert	Readout relative bearing.
5.4. Report torpedo relative bearing	
5.5. Update track in true bearings	
5.6. Monitor track until signal lost	
6. Conduct mine avoidance procedures	Normally based on intel of mine threat area.
6.1. Select mine mode	
6.2. Lock ship's head at 000	
6.3. Set power level and TIOW	
6.4. Monitor acoustic data	Requires solid returns on 2 successive sweeps
6.5. Report contact detection verbally	Bearing and range. No tracks created. Symbology entered later by HMS operator when time allows.
7. Create and maintain operational logs	This process entails manual entry of data into a paper template for all events and actions against a timebase. The task requires a significant level of effort, impacts on workload and may be dropped when operational circumstances demand full attention.

Table 1: List of HMS functions with comments (continued)

4.3 Function Descriptions

For each of the above functions a detailed description is provided using the standard descriptive template outlined in 2.1 in Annex B. Function descriptions are provided down to third level functions only. Descriptions of functions below this level would be repetitious of the information contained in the parent function.

4.4 Function Flow Diagrams

The relationship between functions is depicted in the function flow diagrams in Annex C. These follow a standard format of information flow from left to right. An arrow downward from a function box (that does not lead to another function) indicates a decomposition to lower levels. Since almost all of the functions are linked by "AND" this has been omitted for clarity, thus all horizontal arrows imply an "AND" relationship unless otherwise specified. Overall, the functions are organised sequentially beginning with the highest level functions, followed on successive pages by the detailed decompositions of the first highest level function 1, then followed by the decomposition of function 2, and so on. For each lower function level, the reference to the parent function is provided on the top left of each page.

5. Discussion

5.1 Critical Functions

The primary function of the HMS system is to assist in building and maintaining the underwater and surface water tactical pictures. To successfully achieve this there are a number of interrelated functions each of which is critical in its own right. In order to detect contacts successfully, transmission parameters must be correctly assigned and calculated. To achieve this, a good oceanographic model must have been created. This in turn is dependent upon receiving good environmental information from a number of sources, including bathy operations. Thus, errors in this sequence will result in an ability to detect contacts of interest in the area of interest. Most of the critical functions leading up to actual process of building the picture require a significant operator involvement that requires careful collection and analysis of relevant data.

5.2 Automated Process

The HMS system provides a capability for automated track detection and passive computer aided detection. Nay SMEs reported that these automated functions were generally not used because they tended to generate too many false tracks. These in turn must be directly checked by the operators to determine whether the track was an actual contact of interest or resulting from a spurious source. This process adds significantly to operator workload and detracts from their ability to perform their own contact detection and classification.

5.3 Limitations Of The Analysis

The present analysis represents one component of three function analyses that have been performed on the Halifax Class sonar systems. The other two were the original CANTASS (YARD, 1989) and the update of CANTASS conducted by Humansystems Incorporated and reported separately (Matthews et al, 2001). These analyses have focussed on functional operations by the sonar team from the perspective of the particular systems that are used, namely CANTASS and HMS. This approach creates two problems. First, there is a gap in the overall description, since the remaining components of the sonar suite, namely the SPS and roles of the helo and MPA, have not been analysed. Second and more importantly, the focus on the separate systems does not fully represent the integrated manner in which these systems are used in normal mission operations. At the level of the ASWC the goal is to maintain and build the underwater and surface pictures. The sonar sub-teams led by the SCS (SPS operator, CANTASS operators and HMS operators) contribute to this goal by supplying pieces of the picture to be assembled by the SCS and ASWC. This means that the separate systems tend to operate with an integrated focus, each providing information of a unique type that helps to provide correlative data to build the picture. The degree to which one of the sub-systems will become more or less important in providing this information depends upon a number of factors. These include mission objectives, such as detect or deter or silent passage, the environment, such as deep or shallow water, the thermal environment and seabed, as well as

tactical factors such as information on possible contacts and the types of contact of interest. It is possible that this integrated approach to building the tactical picture will not have been appropriately represented as a result of the separate analyses. Therefore, the reader is encouraged to draw the threads together from across the separate documents to gain a better appreciation of how these systems work in a complementary manner to achieve operational goals.

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Annex A: Glossary of Terms

ADT	Auto Detected Track
ASWC	Anti-Submarine Warfare Commander
CCS	Command and Control System
DTN	Directional-Narrow
DTW	Directional-Wide
HMS	Hull Mounted Sonar
MPA	Maritime Patrol Aircraft
MTP	Maritime Tactical Picture
OIT	Operator Initiated Track
OMNI	Omnidirectional
PCAD	Passive Computer Aided Detection
QAB	Quick Action Button
SCS	Sonar Control Supervisor
SPS	Sonobuoy Processing System
TIOW	Transmission Interval Of the Watch
Tx	Transmission
VOSIW	Velocity Of Sound In Water

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Annex B Function Descriptions

Name of Function	**1.0 Configure System**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure accurate detection
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of Helo/MPA support (viii) availability of other surface sensor support (ix) target speed (x) target range (xi) target aspect (xii) intelligence on target (xiii) contact held by other sensor (xiv) communications status (xv) task group command priorities (xvi) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	<2 minutes
Sub-functions Or Tasks	1.1. Configure operational mode 1.2. Receive frequency assignment and sector allocation from TG 1.3. Set environment parameters 1.4. Select system state 1.5. Configure active mode 1.6. Select ADT/PCAD 1.7. Configure passive mode. 1.8. Set data recorder
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	The output of this function will directly affect the functions *2.0 Configure Transmission Parameters* and *3.0 Build and maintain picture*

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Name of Function	1.1 Configure operational mode[4]
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	1.0 Configure system
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure appropriate system performance for operational context
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of Helo/MPA support (viii) availability of other surface sensor support (ix) target speed (x) target range (xi) target aspect (xii) intelligence on target (xiii) contact held by other sensor (xiv) communications status (xv) task group command priorities (xvi) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	30 seconds if all environmental information is available. If no information available then could take up to 30 minutes.
Sub-functions Or Tasks	1.1.1. Receive environmental information 1.1.2. Obtain and analyse bathy information 1.1.3. Select velocity of sound in water 1.1.4. Calculate predicted ranges for acoustic systems
Sequencing of Sub-functions or Tasks	See function flow diagram
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[4] Normal, shallow water or mine

Name of Function	**1.1.1 Receive and analyse environmental information**
Missions Under Which Function Occurs	All
System Units Which Support Function	510, Bathy
Superordinate Functions	1.1 Configure operational mode
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure appropriate system performance for current environment
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) task group command priorities
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Incorrect settings used for system with consequent failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	Integrated with information from *1.1.2 Obtain and analyse bathy information*

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Name of Function	**1.1.2 Receive and analyse bathy information**
Missions Under Which Function Occurs	All
System Units Which Support Function	Bathy
Superordinate Functions	1.1 Configure operational mode
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure appropriate system performance for current environment
Critical Variables	(ix) own ship speed (x) own ship manoeuvres (xi) weather conditions (xii) oceanographic conditions (xiii) make-up of convoy (xiv) speed of advance of task group and task group manoeuvres (xv) availability of other surface sensor support (xvi) task group command priorities
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Incorrect settings used for system with consequent failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	5-10 mins. Repeated minimum of 4x day; may be performed every 15 minutes in case of threat.
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	Integrated with information from *1.1.1 Receive and analyse environmental information*

Name of Function	**1.1.3 Select velocity of sound in water**
Missions Under Which Function Occurs	All
System Units Which Support Function	510, Bathy
Superordinate Functions	1.1 Configure operational mode
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure appropriate system performance for current environment
Critical Variables	(i) oceanographic conditions
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	Output affects performance of function *3.0 Search and Detect*

Name of Function	**1.1.4 Calculate predicted ranges for acoustic systems**
Missions Under Which Function Occurs	All
System Units Which Support Function	510, Bathy
Superordinate Functions	1.1 Configure operational mode
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure appropriate system performance for current environment
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	Output affects performance of function *3.0 Build and maintain picture*

Name of Function	**1.1.5 Provide oceanographic brief to Ops Room.**
Missions Under Which Function Occurs	All
System Units Which Support Function	510, Bathy
Superordinate Functions	1.1 Configure operational mode
Sequential Categorisation of Functions	Discrete: Performed at least once per day, more frequently if environmental conditions change.
Estimate of Criticality of Function	High to ensure appropriate system performance for current environment
Critical Variables	(vii) own ship speed (viii) own ship manoeuvres (ix) weather conditions (x) oceanographic conditions (xi) make-up of convoy (xii) speed of advance of task group and task group manoeuvres
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

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Name of Function	**1.2 Receive frequency assignment and sector allocation from TG**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	1.0 Configure system
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure own ship active sonar integrates with TG
Critical Variables	(i) make-up of convoy (ii) speed of advance of task group and task group manoeuvres (iii) availability of Helo/MPA support (iv) availability of other surface sensor support (v) intelligence on target (vi) contact held by other sensor (vii) communications status (viii) task group command priorities (ix) number of target
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Inappropriate frequencies would impact performance of other TG active sonar. Inappropriate sector could result in double coverage or missed coverage
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	Output goes to *2.6 Set Directional bearing*

Name of Function	**1.3 Set Environmental Parameters** [5]
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	1.0 Configure system
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure system operates optimally for current ship conditions
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of Helo/MPA support (viii) availability of other surface sensor support
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[5] Ship's roll/pitch, speed, heading

Name of Function	**1.4 Select system state** [5]
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	1.0 Configure system
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) intelligence on target (ix) contact held by other sensor (x) communications status (xi) task group command priorities
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Cannot conduct appropriate sonar operations unless selected appropriately
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[5] Listen or active- default is listen

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Name of Function	**1.5 Configure active mode[7]**
Missions Under Which Function Occurs	All - except silent passage
System Units Which Support Function	510
Superordinate Functions	1.0 Configure system
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) target speed (ix) target range (x) target aspect (xi) intelligence on target (xii) contact held by other sensor (xiii) task group command priorities (xiv) communications status (xv) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised for operational context
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[7] Omni, DTN, DTW

Name of Function	**1.6 Select detection mode[9]**
Missions Under Which Function Occurs	All - except for silent passage, Littoral or mine avoidance.
System Units Which Support Function	510
Superordinate Functions	1.0 Configure system
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) target speed (viii) target range (ix) target aspect (x) contact held by other sensor (xi) task group command priorities (xii) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised for operational context
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[9] ADT/PCAD These functions tend not be used because of the high false alarm rate and resulting increased workload for managing "false" tracks

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Name of Function	1.7 Configure passive mode
Missions Under Which Function Occurs	Deep water and Littoral
System Units Which Support Function	510
Superordinate Functions	1.0 Configure system
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) target speed (viii) target range (ix) intelligence on target (x) contact held by other sensor (xi) task group command priorities (xii) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised for operational context
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	Output influences performance of *3.1 Analyse Passive Acoustic Data*

Name of Function	1.8 Set Data Recorder
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	1.0 Configure system
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	Low
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Inability to playback and analyse a critical event
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

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Name of Function	**2.0. Configure Transmission Parameters**
Missions Under Which Function Occurs	All - except silent passage
System Units Which Support Function	510
Superordinate Functions	
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure accurate detection
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) target speed (ix) target range (x) target aspect (xi) intelligence on target (xii) contact held by other sensor (xiii) communications status (xiv) task group command priorities (xv) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	<1 minute
Sub-functions Or Tasks	2.1. Define transmission groups 2.2. Select transmission group for operational context (normal, shallow water, mine avoidance) 2.3. Select transmission parameters (range/transmission interval of the watch -TIOW, frequency, mode, power level- type FM/CW) 2.4. Select auto or manual transmission initiation 2.5. Select synchronisation parameters (Iroquois only) 2.6. Set directional transmission bearing
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	Depends on *1.0 Configure System* Output influences performance of *3.0 Build and Maintain Picture, 6.0 Conduct Mine Detection*

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Name of Function	2.1 Define Transmission Groups
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	2.0 Configure Transmission Parameters
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) target speed (ix) target range (x) target aspect (xi) intelligence on target (xii) contact held by other sensor (xiii) task group command priorities (xiv) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised to detect signals of interest
Estimate of Time to Completion	
Sub-functions Or Tasks	2.1.1 Set frequency
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

Name of Function	**2.1.1 Set Frequency**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	2.1 Define Transmission Groups
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) target speed (ix) target range (x) target aspect (xi) intelligence on target (xii) contact held by other sensor (xiii) task group command priorities (xiv) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised to detect signals of interest
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

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Name of Function	2.2 Select Transmission Group for Operational Context[9]
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	2.0 Configure Transmission Parameters
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) target speed (ix) target range (x) target aspect (xi) intelligence on target (xii) contact held by other sensor (xiii) task group command priorities (xiv) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised to detect signals of interest
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[9] Normal, shallow water, mine avoidance

Name of Function	2.3 Select Transmission Parameters[10]
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	2.0 Configure Transmission Parameters
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) target speed (ix) target range (x) target aspect (xi) intelligence on target (xii) contact held by other sensor (xiii) task group command priorities (xiv) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised to detect signals of interest
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[10] Range/transmission interval of the watch (TIOW), frequency, mode, power level, type -FM/CW

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Name of Function	**2.3.1 Select Mode**[11]
Missions Under Which Function Occurs	All (DTW only for mines)
System Units Which Support Function	510
Superordinate Functions	2.3 Select Transmission Parameters (range/transmission interval of the watch (TIOW), frequency, mode, power level- type FM/CW)
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) target speed (ix) target range (x) target aspect (xi) intelligence on target (xii) contact held by other sensor (xiii) task group command priorities (xiv) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised to detect signals of interest
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[11] Omni, DTN, DTW

Name of Function	2.4 Select Auto or Manual Transmission Initiation
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	2.0 Configure Transmission Parameters
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) task group command priorities
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised to detect signals of interest
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

Name of Function	2.5 Select synchronisation parameters (Iroquois Class only)
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	2.0 Configure Transmission Parameters
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) Parameters/settings of other active sonar system
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Receiver sensitivity reduced and detection impaired
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

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Name of Function	2.6 Set Directional Transmission Bearing
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	2.0 Configure Transmission Parameters
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High
Critical Variables	(i) make-up of convoy (ii) speed of advance of task group and task group manoeuvres (iii) target speed (iv) target range (v) target aspect (vi) intelligence on target (vii) contact held by other sensor (viii) task group command priorities
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	System performance not optimised to detect signals of interest
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	NA
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

Name of Function	**3.0 Build and maintain picture**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of Helo/MPA support (viii) availability of other surface sensor support (ix) target speed (x) target range (xi) target aspect (xii) intelligence on target (xiii) contact held by other sensor (xiv) communications status (xv) task group command priorities (xvi) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	3.1 Analyse passive acoustic data 3.2 Analyse active acoustic data
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	Depends on output of *1.0 Configure System* and *2.0 Configure Transmission Parameters* *Output influences 4.0 Manage Tracks*

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Name of Function	**3.1 Analyse Passive Acoustic Data**[12]
Missions Under Which Function Occurs	Deep water, shallow water, silent passage.
System Units Which Support Function	510
Superordinate Functions	3.0 Build and maintain picture
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of Helo/MPA support (viii) availability of other surface sensor support (ix) target speed (x) target range (xi) target aspect (xii) intelligence on target (xiii) contact held by other sensor (xiv) communications status (xv) task group command priorities (xvi) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	3.1 1 Monitor passive display 3.1.2 Detect bearing of noise spoke 3.1.3 Listen to source 3.1.4 Classify track 3.1.5 Create regional track 3.1.6 Report track to CCS 3.1.7 Update track
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

[12] This tends to be used only for providing correlative evidence since audio quality is poor and background noise may be high, with a potential for many false alarms

Name of Function	**3.1.1 Monitor passive display[13]**
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	3.1 Analyse passive acoustic data
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of Helo/MPA support (viii) availability of other surface sensor support (ix) target speed (x) target range (xi) target aspect (xii) intelligence on target (xiii) contact held by other sensor (xiv) communications status (xv) task group command priorities (xvi) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

[13] Using broad band

Name of Function	3.1.2 Detect bearing of noise spoke
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.1 Analyse passive acoustic data
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of Helo/MPA support (viii) availability of other surface sensor support (ix) target speed (x) target range (xi) target aspect (xii) intelligence on target (xiii) contact held by other sensor (xiv) communications status (xv) task group command priorities (xvi) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	3.1.3 Listen to Source
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.1 Analyse passive acoustic data
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of Helo/MPA support (viii) availability of other surface sensor support (ix) target speed (x) target range (xi) target aspect (xii) intelligence on target (xiii) contact held by other sensor (xiv) communications status (xv) task group command priorities (xvi) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	3.1.4 Classify Track
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.1 Analyse passive acoustic data
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure contacts of interest are detected
Critical Variables	(i) communications status (ii) availability of correlative data from CANTASS, SPS or MPA
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Incomplete picture
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

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Name of Function	3.1.5 Create Regional Track
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.1 Analyse passive acoustic data
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure contacts of interest are detected
Critical Variables	(i) communications status
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Incomplete picture
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	HMS Operator
Interdependency of Functions	

Name of Function	3.1.6 Report Track to CCS
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.1 Analyse passive acoustic data
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure contacts of interest are passed up to command level and picture is complete
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Incomplete MTP
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

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Name of Function	3.1.7 Update Track
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.1 Analyse passive acoustic data
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) target speed (viii) target range (ix) target aspect (x) intelligence on target (xi) contact held by other sensor (xii) communications status (xiii) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Incomplete/inaccurate picture
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

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Name of Function	3.2 Analyse Active Acoustic Data
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.0 Build and maintain picture
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	(i) oceanographic conditions (ii) make-up of convoy (iii) speed of advance of task group and task group manoeuvres (iv) target speed (v) target range (vi) target aspect (vii) intelligence on target (viii) contact held by other sensor (ix) task group command priorities (x) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	Two minutes after initial detection
Sub-functions Or Tasks	3.2.1 Select acoustic data presentation mode 3.2.2 Selective active mode and initiate transmission 3.2.3 Monitor acoustic data 3.2.4 Detect acoustic signal 3.2.5 Process contact 3.2.6 Maintain detection
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

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Name of Function	3.2.1 Select acoustic data presentation mode[14]
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.2 Analyse Active Acoustic Data
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	(i) oceanographic conditions (ii) make-up of convoy (iii) speed of advance of task group and task group manoeuvres (iv) target speed (v) target range (vi) target aspect (vii) intelligence on target (viii) contact held by other sensor (ix) task group command priorities (x) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	3.2.2 Selective active mode and initiate transmission
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.2 Analyse Active Acoustic Data
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

[14] PSCAN, ASCAN, BSCAN, TSCAN, DSCAN, CSCAN or dual combinations

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Name of Function	**3.2.3 Monitor acoustic data**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.2 Analyse Active Acoustic Data
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	(i) oceanographic conditions (ii) make-up of convoy (iii) speed of advance of task group and task group manoeuvres (iv) target speed (v) target range (vi) target aspect (vii) intelligence on target (viii) contact held by other sensor (ix) task group command priorities (x) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	**3.2.4 Detect acoustic signal**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.2 Analyse Active Acoustic Data
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	(i) oceanographic conditions (ii) make-up of convoy (iii) speed of advance of task group and task group manoeuvres (iv) target speed (v) target range (vi) target aspect (vii) intelligence on target (viii) contact held by other sensor (ix) task group command priorities (x) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

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Name of Function	**3.2.5 Process contact**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.2 Analyse Active Acoustic Data
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	(i) oceanographic conditions (ii) make-up of convoy (iii) speed of advance of task group and task group manoeuvres (iv) target speed (v) target range (vi) target aspect (vii) intelligence on target (viii) contact held by other sensor (ix) task group command priorities (x) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	3.2.5.1. Select track management mode[15] 3.2.5.2. Create track 3.2.5.3. Localise track 3.2.5.4. Update tracks 3.2.5.5. Correlate with passive data 3.2.5.6. Classify track 3.2.5.7. Report regional track 3.2.5.8. Assess track 3.2.5.9. Pass contact information/report to CCS
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

[15] Modes are OIT, ADT, PCAD. ADT and PCAD modes are rarely used because of the high false alarm rates resulting in increased workload for track management

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Name of Function	**3.2.6 Maintain detection**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	3.2 Analyse Active Acoustic Data
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure contacts of interest are detected and classified
Critical Variables	(i) oceanographic conditions (ii) make-up of convoy (iii) speed of advance of task group and task group manoeuvres (iv) target speed (v) target range (vi) target aspect (vii) intelligence on target (viii) contact held by other sensor (ix) task group command priorities (x) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Failure to detect threat with subsequent potential danger to ship or TG
Estimate of Time to Completion	
Sub-functions Or Tasks	3.2.6.1 Adjust Tx parameters as required
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	**4.0 Manage Tracks**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure accuracy of MTP
Critical Variables	(i) task group command priorities
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Incomplete/inaccurate MTP
Estimate of Time to Completion	
Sub-functions Or Tasks	4.1. Delete active tracks 4.2. Drop and restore tracks 4.3. Process lost contacts
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	Output influences *3.0 Build and maintain picture*

Name of Function	**4.1 Delete active tracks**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	4.0 Manage Tracks
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure accuracy of MTP
Critical Variables	(i) task group command priorities
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Incomplete/inaccurate MTP
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	Output influences *3 0 Build and maintain picture*

Name of Function	**4.2 Drop and Restore Tracks**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	4.0 Manage Tracks
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure accuracy of MTP
Critical Variables	(i) task group command priorities
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Incomplete/inaccurate MTP
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	Output influences *3.0 Build and maintain picture*

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Name of Function	**4.3 Process Lost Contacts**
Missions Under Which Function Occurs	All
System Units Which Support Function	510
Superordinate Functions	4.0 Manage Tracks
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure accuracy of MTP
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) target speed (viii) target range (ix) target aspect (x) intelligence on target (xi) contact held by other sensor (xii) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Incomplete/inaccurate picture
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	Output influences *3.0 Build and maintain picture*

Name of Function	**4.4 Correlate tracks**
Missions Under Which Function Occurs	All
System Units Which Support Function	510, SPS, CANTASS, MPA, Helo
Superordinate Functions	4.0 Manage Tracks
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure accuracy of picture
Critical Variables	(xiii) target speed (xiv) target range (xv) target aspect (xvi) intelligence on target (xvii) contact held by other sensor (xviii) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Track classified incorrectly resulting in incomplete/inaccurate picture
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	Output influences *3.0 Build and maintain picture*

Name of Function	**5.0 Conduct torpedo procedures**
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) target speed (ix) target range (x) intelligence on target (xi) contact held by other sensor (xii) communications status (xiii) task group command priorities (xiv) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Damage/loss of ship from torpedo
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

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Name of Function	**5.1 Monitor passive acoustic data[16]**
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	5.0 Conduct torpedo procedures
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of Helo/MPA support (viii) availability of other surface sensor support (ix) target speed (x) target range (xi) target aspect (xii) intelligence on target (xiii) contact held by other sensor (xiv) communications status (xv) task group command priorities (xvi) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Damage/loss of ship from torpedo
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

[16] Operator looks for noise spoke

Name of Function	**5.2 Analyse for torpedo signature**
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	5.0 Conduct torpedo procedures
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	(xvii) own ship speed (xviii) own ship manoeuvres (xix) weather conditions (xx) oceanographic conditions (xxi) make-up of convoy (xxii) speed of advance of task group and task group manoeuvres (xxiii) availability of Helo/MPA support (xxiv) availability of other surface sensor support (xxv) target speed (xxvi) target range (xxvii) target aspect (xxviii) intelligence on target (xxix) contact held by other sensor (xxx) communications status (xxxi) task group command priorities (xxxii) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Damage/loss of ship from torpedo
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	**5.3 Select QAB Alert**
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	5.0 Conduct torpedo procedures
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Damage/loss of ship from torpedo
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

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Name of Function	5.4 Report Torpedo Relative Bearing
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	5 0 Conduct torpedo procedures
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Damage/loss of ship from torpedo
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	5.5 Update track in true bearings
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	5.0 Conduct torpedo procedures
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Damage/loss of ship from torpedo
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	5.6 Monitor track until signal lost
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	5.0 Conduct torpedo procedures
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Damage/loss of ship from torpedo
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

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Name of Function	**6.0 Conduct mine avoidance procedures**
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) availability of other surface sensor support (viii) intelligence on target (ix) contact held by other sensor (x) communications status (xi) task group command priorities (xii) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	
Consequences of Failure to Complete A Function	Damage/loss of ship from contact with mine
Estimate of Time to Completion	
Sub-functions Or Tasks	6.1. Select mine mode 6.2. Lock ship's head at 000 6.3. Set power level and TIOW 6.4. Monitor acoustic data 6.5. Report contact detection verbally
Sequencing of Sub-functions or Tasks	See function flow diagrams
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	**6.1 Select mine mode**
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	6.0 Conduct mine avoidance procedures
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Damage/loss of ship from contact with mine
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

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Name of Function	6.2 Lock ship's head at 000
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	6.0 Conduct mine avoidance procedures
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Damage/loss of ship from contact with mine
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	6.3 Set power level and TIOW
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	6.0 Conduct mine avoidance procedures
Sequential Categorisation of Functions	Discrete
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Low
Consequences of Failure to Complete A Function	Damage/loss of ship from contact with mine
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

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Name of Function	6.4 Monitor acoustic data[17]
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	6.0 Conduct mine avoidance procedures
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	(i) own ship speed (ii) own ship manoeuvres (iii) weather conditions (iv) oceanographic conditions (v) make-up of convoy (vi) speed of advance of task group and task group manoeuvres (vii) target range (viii) intelligence on target (ix) contact held by other sensor (x) communications status (xi) task group command priorities (xii) number of targets
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Damage/loss of ship from contact with mine
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator/software/hardware
Interdependency of Functions	

Name of Function	6.5 Report contact detection[18]
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	6.0 Conduct mine avoidance procedures
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Damage/loss of ship from contact with mine
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[17] Requires solid returns on two successive sweeps.
[18] Verbal report of bearing and range. Symbology entered later by HMS operator when time allows.

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Name of Function	6.5 Report contact detection[19]
Missions Under Which Function Occurs	Deep water, shallow water
System Units Which Support Function	510
Superordinate Functions	6.0 Conduct mine avoidance procedures
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	High to ensure safety of ship or TG
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Damage/loss of ship from contact with mine
Estimate of Time to Completion	
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

Name of Function	7.0 Create and maintain operational logs.
Missions Under Which Function Occurs	All
System Units Which Support Function	
Superordinate Functions	
Sequential Categorisation of Functions	Continuous
Estimate of Criticality of Function	Critical only for post-event analysis
Critical Variables	
Required Quality of Output for Function	High
Estimate of Probability of Failure to Complete a Function	Medium
Consequences of Failure to Complete A Function	Inability to trace operational events and actions after the fact
Estimate of Time to Completion	This is a time-consuming, repetitive task that requires manual entry of data into templates with no support for short-cuts or "smart" data entry by the system.
Sub-functions Or Tasks	
Sequencing of Sub-functions or Tasks	
Allocation of Function to Operator, Software or Hardware	Operator
Interdependency of Functions	

[19] Verbal report of bearing and range. Symbology entered later by HMS operator when time allows

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Annex C: Function Flow Diagrams

The function flow diagrams use a standard format of information flow from left to right. An arrow downward from a function box indicates a decomposition to lower levels. Since almost all of the functions are linked by "AND" this has been omitted for clarity, thus all horizontal arrows imply and "AND" relationship unless otherwise specified. Overall, the functions are organised sequentially beginning with the highest level functions, followed on successive pages by the detailed decompositions of the first highest level function 1, then followed by the decomposition of function 2, and so on. For each lower function level, the reference to the parent function is provided on the top left of each page.

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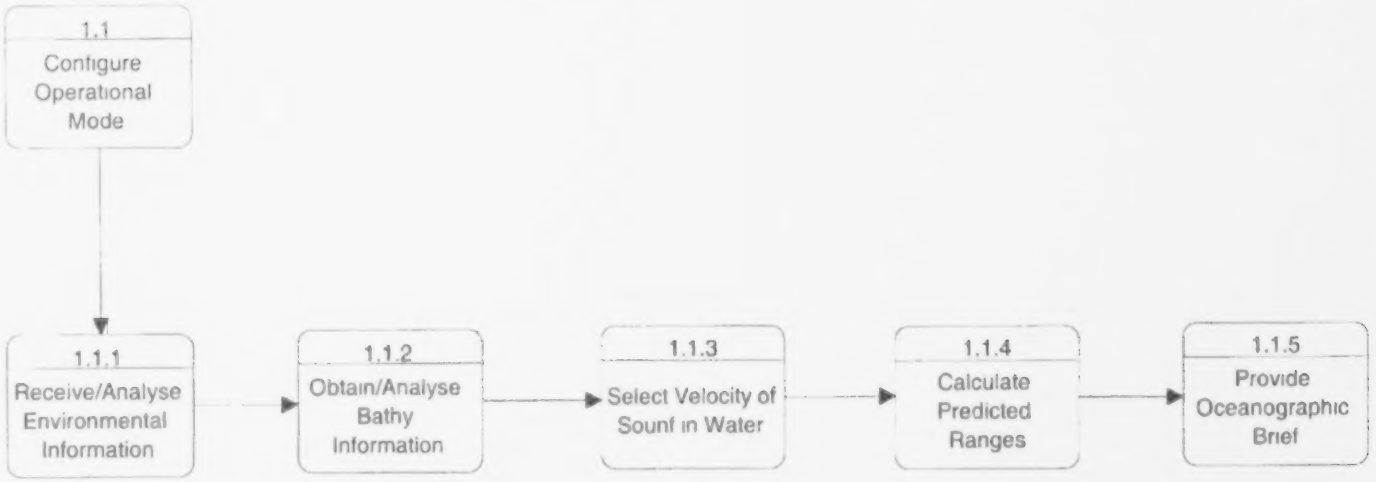

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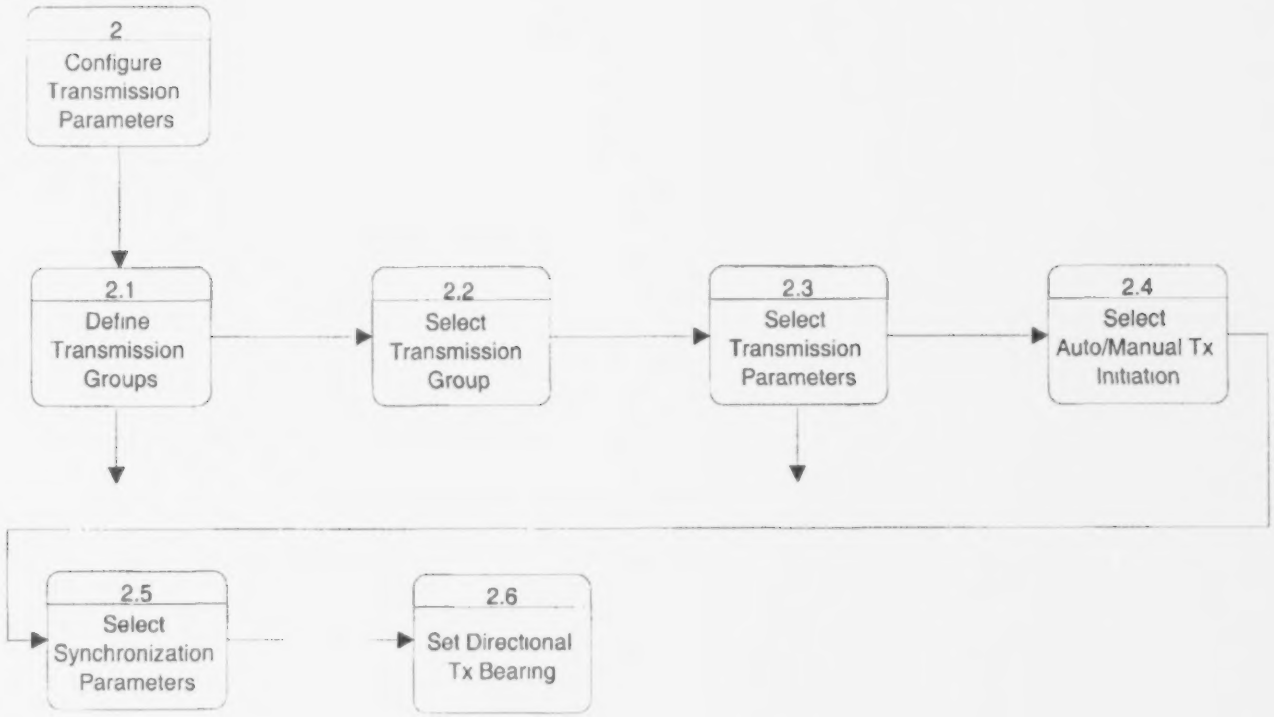

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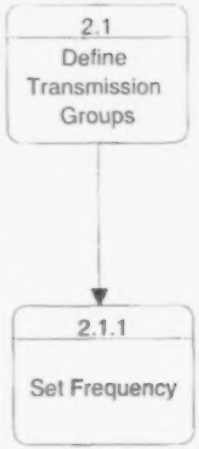

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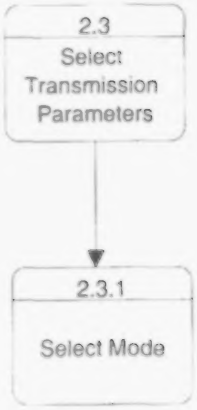

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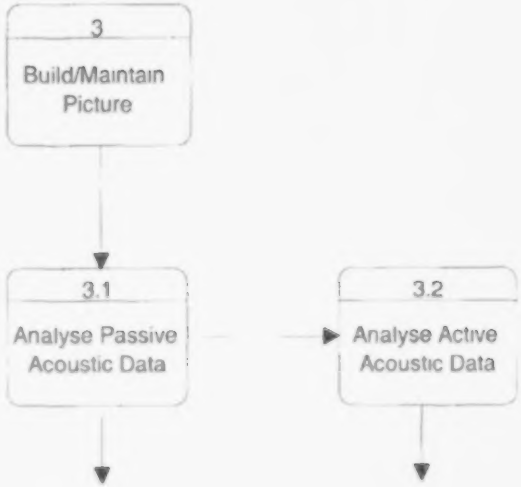

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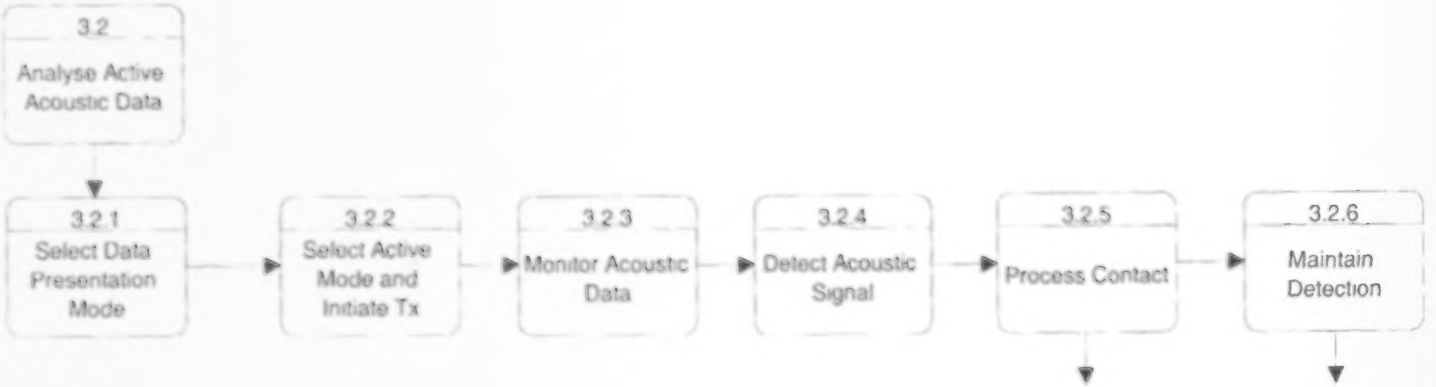

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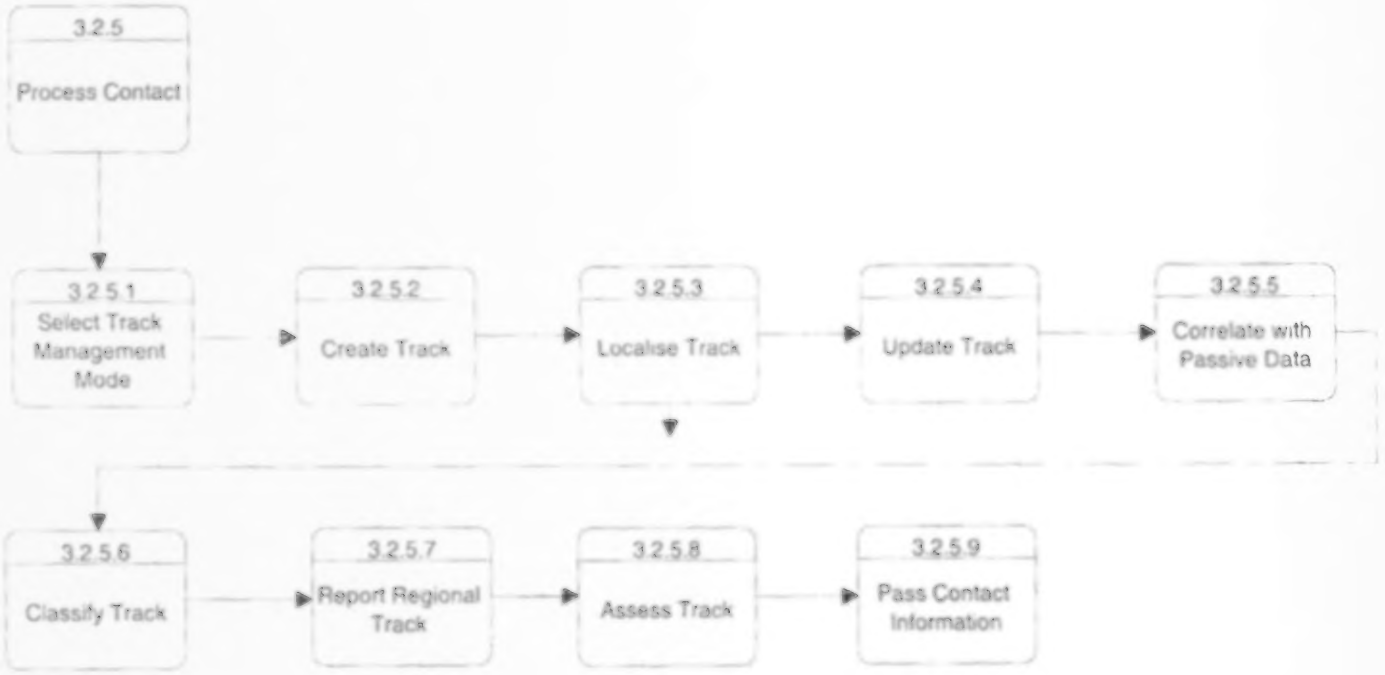

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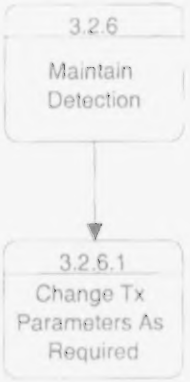
3.2.6
Maintain Detection
3.2.6.1
Change Tx Parameters As Required

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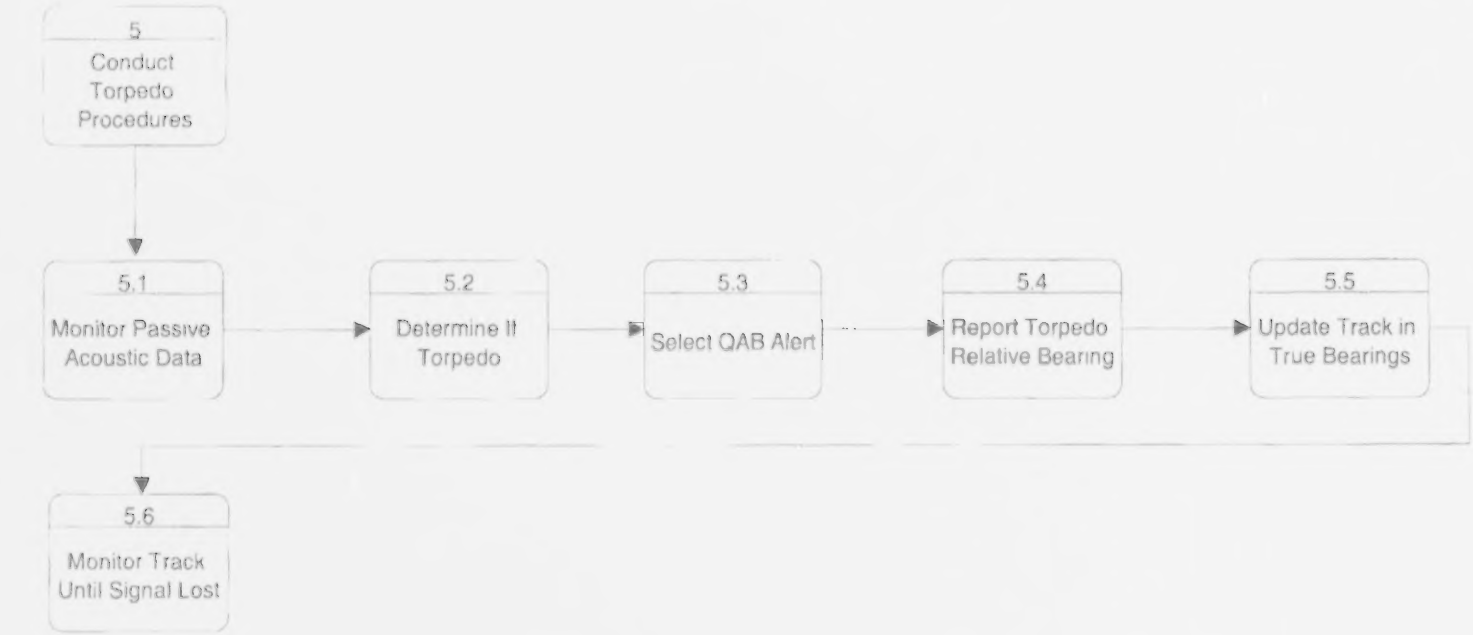
5
Conduct Torpedo Procedures
5.1
Monitor Passive Acoustic Data
5.2
Determine If Torpedo
5.3
Select QAB Alert
5.4
Report Torpedo Relative Bearing
5.5
Update Track in True Bearings
5.6
Monitor Track Until Signal Lost

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DOCUMENT CONTROL DATA SHEET

1a PERFORMING AGENCY

Humansystems Incorporated, 111 Farquhar St., 2nd floor, Guelph, ON N1H 3N4

2 SECURITY CLASSIFICATION

UNCLASSIFIED
Unlimited distribution -

1b. PUBLISHING AGENCY

DCIEM

3 TITLE

(U) Function Analysis of AN/SQS-510 Hull Mounted Sonar

4. AUTHORS

Michael L. Matthews Robert D.G. Webb

5 DATE OF PUBLICATION

January 30 , 2002

6 NO OF PAGES

89

7 DESCRIPTIVE NOTES

8 SPONSORING/MONITORING/CONTRACTING/TASKING AGENCY

Sponsoring Agency
Monitoring Agency:
Contracting Agency DCIEM
Tasking Agency

9. ORIGINATORS DOCUMENT NO

Contract Report CR 2002-003

10 CONTRACT GRANT AND/OR PROJECT NO

PWGSC Contract No. W7711-7-7404/01-SV, Call-Up 7404-12

11 OTHER DOCUMENT NOS.

12. DOCUMENT RELEASABILITY

Unlimited distribution

13 DOCUMENT ANNOUNCEMENT

Unlimited announcement

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14 ABSTRACT

(U) This report provides the results of a function analysis of the AN/SQS-510 Hull Mounted Sonar deployed on Halifax class ships. The analysis was based upon available system and Navy training documentation and interviews with Defence Scientist and Navy subject matter experts. The analysis revealed a high degree of dependency among a number of critical functions whose accurate completion is required for the successful detection and classification of contacts of interest. These functions included the determination of the oceanographic model, the appropriate configuration of transmission parameters and the correct selection and use of display modes on the operator's console. The validation interviews also revealed that automated processes for detection were generally not used under operational conditions because of high false alarm rates and associated increases in operator workload. The present analysis should be interpreted in conjunction with an earlier report that provided an updated function analysis of the CANTASS system.

#517348

CA020635

15 KEYWORDS, DESCRIPTORS or IDENTIFIERS

(U) Operator Machine Interface; AN/SQS-510; Hull Mounted Sonar; TIAPS; function analysis; sonar combat systems; human factors